

SUMMARY
SOCKEYE ENHANCEMENT MONITORING
ADULT MARK-RECAPTURE ESCAPEMENT ESTIMATE—1997
Virginia Lake, ADFG-107-40-10070, Mainland

Background

The Virginia Lake Sockeye Enhancement and Lake Enrichment Project has been a cooperative venture with multiple partners. NSRAA (Northern Southeast Regional Aquaculture Association), ADFG-FRED/CFMD (Alaska Department of Fish and Game-Fisheries Rehabilitation, Enhancement, and Development/Commercial Fisheries Management and Development), SSRAA (Southern Southeast Regional Aquaculture Association), and Forest Service jointly performed the pre-project investigations in 1986. Wrangell Gillnetters joined the partnership in 1991. Roles and responsibilities of the partners changed as the project evolved.

The Mill Creek combination steepness and pool-and-weir fishway was constructed in 1988. MacDonald Lake egg-takes for incubation and donor fry stocking occurred from 1989 through 1994. Limnological and sockeye survival monitoring was initiated in 1988 and continues to present. The 1989 fry release prior to the plankton bloom resulted in a severe reduction in the zooplankton population and subsequent poor sockeye survival. Nutrient enrichment using liquid fertilizer began in 1991 and continued through 1996. Total production was anticipated to be 40,000-60,000 adult sockeye with an eventual escapement of 20,000-30,000 adults at full production with enrichment. Escapement surveys began in 1993 and continue to present. An impedance tunnel and counter were installed at the fishway in 1995 an attempt to increase confidence in escapement estimates.

Methodology

Per mutual agreement among the enhancement monitoring partners (ADFG, SSRAA, USFS), the impedance tunnel and counter provided by SSRAA were removed by FS personnel on 7/28/97. It was replaced with a portable aluminum channel rail-and-conduit weir installed just upstream from the water inlet to the steepness (Appendix I). The picket holes were spaced 2-inches o.c., leaving a space of about 1-1/4 inches between pickets. One end of the rails was anchored to a length of #8 rebar socketed in the bedrock adjacent the corner of the training wall. The other end was anchored similarly adjacent the bedrock edge of the resting pool, about eight feet away from the corner of the fishway training wall. Installation took place about midway through the flood tide each day of operation. The weir was removed each day after marking and release operations.

The weir was fished intermittently for statistical and other reasons: 1) It was felt that enough fish could be tagged for a mark-recapture estimate of abundance without operating the weir full-time; 2) Although not all fish passing the fishway would have an equal chance of being captured and marked, it was assumed all fish would have an equal chance of being sampled on the spawning grounds; 3) All marked and unmarked fish would have an opportunity to have completely mixed prior to their arrival on the spawning grounds; 4) Fish migrate from saltwater through the fishway during a 3 to 4-hour window associated with the timing and height of high tide; and 5) Establishment of a field camp for the operation of a full-time weir would compromise other scheduled projects.

Fish were dipnetted using a large sport landing net. Species other than sockeye were not measured, but were just noted by species and sex and released immediately upstream of the weir to continue their upstream migration. Most smaller species such as cutthroat trout and Dolly Varden char passed through the mesh of the dipnet if they had not already passed through the pickets in the weir. Because of the proximity to a population center and the likelihood of processed fish being caught and consumed by local sport and subsistence/personal users, anesthesia using MS-222 was not employed. Sockeye were placed in a restraining cradle (beginning on 8/21) directly from the net for measurement and marking (Appendix II). Prior to the employment of the cradle, tagged fish were placed in a quiet resting pool approximately 5 meters upstream of the weir to recover from handling stress. Use of the cradle reduced handling time and stress such that processed fish could be released adjacent the training wall.

Enhanced sockeye were tagged with a numbered yellow spaghetti tag (Appendix III). The tags were affixed in standard fashion, through the upper back just below and slightly ahead of the posterior end of the dorsal fin and tied with a square knot. Sequentially numbered tags were chosen in hopes of determining ripening time spent in the lake by comparing freshwater entry to arrival on the spawning grounds. Enhanced sockeye were given a secondary mark with a hole punch in the left opercle in case the spaghetti tag was shed. Although the number would be lost, the secondary mark could still be used to estimate population based on mark-recapture.

Native sockeye were tagged with Floy T-bar anchor tags on the right-hand side under the dorsal fin. They were given a secondary mark with a right-side opercle punch in order to have a lasting mark in case the tag was shed.

Other species were noted on the data sheets but no other data were logged. These fish were released unmarked immediately just upstream of the weir with minimal handling.

Results

Weir Operation.

The weir was operated a total of 13 days from August 1 through September 12. The longest duration of consecutive days was 7 from August 16 through August 22. The weir was operated on only 2 days after August 22 because of high flows. Operation was dependent upon timing of the tides during daylight hours. No field camp was established. The crew commuted from Wrangell by boat, a trip of 20 minutes, one way. The following summarizes the fish handled at the weir:

<u>Enhanced RS</u>	<u>Native RS</u>	<u>Jack RS</u>	<u>Chinook</u>	<u>Chum</u>	<u>Pink</u>	<u>Cutthroat</u>
284	45	2	2	7	2	1

Handling mortalities: 1 enhanced sockeye
3 native sockeye

The following summarizes daily results at the weir:

	ENHANCED RS		AD	NATIVE RS		SOCKEYE	OTHER SPP				WEIR TIME		HI TIDE
Date	Male	Female	CLP	Male	Female	JACKS	KS	CS	PS	CT	In	Out	Time/Ht
8/1/97	2	9		12 total		2	1M			1			
8/4/97	4	9		1	4								
8/6/97	4	9			3						1450	1630	1601/13.2
8/10/97	2	1									800	1020	0602/10.0
8/16/97	8	11		1	1						1000	1530	1240/12.6
8/17/97	21	23	2	1	1			1M			1150	1654	1323/14.0
8/18/97	9	17		2	6		1F	3M	2F		1330	1620	1405/15.1
8/19/97	10	17	3	4	3			1M			1220	1535	1446/15.8
8/20/97	23	15	5		2	2		1M			1430	1715	1528/16.1
8/21/97	25	22	4	1	2			1M			1345	1715	1611/16.0
8/22/97	22	13	5								1530	1705	1657/15.4
9/4/97	4	3		3							1220	1725	1523/13.8
9/12/97	1										826	1245	1015/12.7
totals	135	149	19	11	22	4	2	7	2	1			

	1994	1995	1996	1997
# samples	5	55	127	9
mean	562	594	652	655
median	567	589	654	664
mode		620	640	687
range	536-595	499-689	541-734	609-687

A graphic representation of the sockeye data is presented in Appendix IV, Cumulative Handling Summary.

Summary of MEF Length Data From Enhanced Sockeye At Weir

135 males: mean length = 603mm; mode = 610mm; median = 601mm; range: 528 - 670mm

149 females: mean length = 583mm; mode = 610mm; median = 581mm; range: 442 - 643mm

Other MEF Data. Two heads were taken from ad-clipped fish found during monitoring. The MEF lengths of these sampled fish were 565 and 610mm.

Other Length Data

Lengths recorded from fish sampled from landings in the commercial fishery are taken as fork lengths (NF-nose to fork). Lookup tables are not available from which to derive comparable MEF lengths. Such CWT data from Virginia Lake sockeye is readily available from the Tag Lab's website (Tagotoweb) for the period 1994 to present. The table below summarizes the fork length data from those samples from the gillnet and seine landings. The number of samples (heads) gives an indication of relative run strength in each year. These data are derived from the same dataset for Virginia Lake as those included in Appendix 6, Comparative Summary of Strata of Sockeye Harvest in Southeast Region. Sample size notwithstanding, the limited data indicates that, relative to previous years' runs, this year's run appears to have been slightly healthier in terms of the size of individual fish. However, the data may be biased by the selectivity of gillnet mesh size. This bias could be less than consistent over the years due to market prices and, thus, species targeted by the fishery and mesh size employed.

Stock Differentiation. The length-frequency histogram (Appendix V) derived from lengths taken from all sockeye (native and enhanced) handled at the intermittent weir would seem to indicate a distinction between stocks at 510mm. However, it is believed that there were some enhanced sockeye that were 510mm and under. These would be "2-ocean" MacDonald stock, or $x.2$ fish. The bulk of the MacDonald return has historically been comprised of "3-ocean" or $x.3$ fish (T. Zadina, ADFG, personal communication). Recognition of stock during handling and tagging was based on phenotypic characters in addition to length. The native stock is known to local fishers as "bullet" sockeye, reflective of their distinctive severely fusiform shape and the general lack of thick back development exhibited by the enhanced donor stock (MacDonald Lake, Cleveland Peninsula). Admittedly, there were some fish that appeared borderline between the two stocks and were treated, for the purpose of tagging, as native stock. These were very likely, however, 2-ocean enhanced stock.

Tagging, Enhanced Stock. A total of 284 enhanced sockeye were spaghetti-tagged. One fish did not recover from handling. Four fish were recaptured at the weir after drifting back over the falls and re-entering the fishway. The following table summarizes Spaghetti Tag Recoveries:

TAG NUMBER	DATE MARKED	DATE RECOVERED	LOCATION FOUND	CONDITION OF FISH
S-0015	8/04/97	9/30/97	lower Glacier Creek	fresh carcass, whole
S-0027	8/06/97	9/30/97	lower Glacier Creek	fresh carcass, whole
S-0033	8/06/97	9/30/97	mouth, SArm Porterfield	no carcass, just tag
S-0255	8/22/97	9/30/97	lower Glacier Creek	carcass 95% consumed

Tagging, Native Stock. A total of 45 native sockeye were handled at the weir, 33 of which were tagged. Three did not recover from handling stress. None were observed nor recovered during escapement surveys.

Escapement Surveys

A total of **four escapement surveys** were performed in 1997:

- 1) three arms of Porterfield Creek on 09/08 (one crew)
- 2) flight cancelled due to weather on 09/19
- 3) lake body and outlet on 09/25 and main inlet streams on 09/26 (one crew, two succeeding days)
- 4) lake body, outlet, and main inlet streams on 09/30 (two crews simultaneously)
- 5) lake body, outlet, and main inlet streams on 10/07 (two crews simultaneously)

The following table summarizes Escapement Survey Results:

DATE	LAKE SHORELINE	OUTLET	GLACIER CR	PORTERFIELD CREEK			REMARKS
				South Arm	North Arm	Middle Arm	
9/8/97	not surveyed	not surveyed	not surveyed	none	none	none	
9/19/97	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed	flight cancelled
9/26/97	2 live, 1 dead	50 live	2 live	1 live	1 live, 1 dead	not surveyed	report of many
	1 spaghetti tag	4 spaghetti tag		(mouth only)	(mouth only)		floaters week prior
9/30/97	1 live, 1 dead	35 live	73 live, 4 dead	35 live, 6 dead	47 live	4 live, 3 dead	many beach redds
		2 spaghetti tag	4 spaghetti tag	1 spaghetti tag	1 spaghetti tag		Glacier to cabin
10/7/97	2 dead	12 live	35 live, 5 dead	14 live, 4 dead	20 live, 1 dead	not surveyed	survey aborted-wind
			1 spaghetti tag				

This was the first year since adult monitoring began that evidence of **beach spawning** has been observed. Although a count of beach redds was not made, the number appeared significant. A report was received from a moose hunter occupying the public recreation cabin stating that “*many floaters*” were in the lake on 9/19/97.

Escapement Estimate

Marking of fish was not likely accomplished at a rate proportional to their passing abundance. Trapping and tagging was not only strictly diurnal, but was also restricted to the period of incoming tide as well as the period when a radio dispatcher was available in compliance with Forest Service water travel safety policy. Additionally, there were periods of high flows when the gear could not be used because of its existing configuration. This bias is compounded by the very high likelihood that at least some 2-ocean enhanced fish were not included in the enhanced marked population.

The escapement estimate is based upon the sub-sample made on 9/30/97. This is the only survey with enough marked and unmarked fish upon which to base an estimate. Total “marked” includes observed (on live fish) and recovered (from dead fish) spaghetti tags. Although the overall sampling effort did not produce the expected sample size, we found no indication that spaghetti tags were shed; therefore, it is assumed all spaghetti tags remained intact. The following calculations were made to arrive at the estimated range of escapement:

Chapman's v. Petersen

$$N = \frac{(M+1)(C+1)}{R+1}$$

$$N = \frac{(284)(210)}{8+1}$$

$$N = \frac{59,640}{9}$$

$$N = 6627$$

Lower Limit

$$N = \frac{(M+1)(C+1)}{R+1}$$

$$N = \frac{(284)(210)}{3.4+1}$$

$$N = \frac{59,640}{4.4}$$

$$N = 13,555$$

Upper Limit

$$N = \frac{(M+1)(C+1)}{R+1}$$

$$N = \frac{(284)(210)}{15.8+1}$$

$$N = \frac{59,640}{16.8}$$

$$N = 3,550$$

Using Chapman's version of Petersen's formula and Ricker's limits for the Poisson distribution, the escapement estimate is **6627** and the range for 95% confidence is **3,550 to 13,555**.

Other Use Data

Harvest data from *personal use* permit return reports were not available at the time of this writing.

Discussion

Weir Operation

The portable weir worked well for adult sockeye. However, flows near or exceeding the top of the training wall made conditions difficult for capturing fish and virtually impossible for processing fish via the existing gear configuration. The presence of a bedrock pool just upstream of the fishway facilitated good recovery from handling stress prior to employment of a restraining cradle. The cradle decreased processing time and reduced apparent stress such that fish were released adjacent the training wall where the cradle was hung. No mortalities were suffered after the restraining cradle was employed. Our thanks to Craig Ferrington of ADFG for enlightening us about this tool.

The conduit holes in the rail pieces were spaced such that additional holes could be drilled in the rail to tighten the spacing, therefore enabling the entrapment and enumeration of smaller fish such as Dolly Varden char and cutthroat trout. This could be performed in the future if such data is deemed necessary.

Installation of a flashboard just upstream of the steep pass was attempted but was unsuccessful. Lower flows are needed than what existed at the time. Freshwater entry is so controlled by tide that it seems counting over a flashboard could be used in the future once an index is constructed with a few years' use of the weir in combination with mark and recapture. This would not necessarily eliminate the need for escapement surveys but would reduce the extra effort of mobilization, installation, uninstallation, and de-mobilization of the weir. It is not known whether the flashboard would improve detection during high flows.

Marking

76 % of the enhanced sockeye were marked during a core period of 6 days, 46% of the trapping and marking effort in terms of days spent. This period corresponded with the highest tides in what is believed to be the return window. This period was followed by a week of high flows which precluded the marking operation as it was configured at the time. Many fish may have moved through undetected during this high water period, but then again, the bulk of the return may have already passed through via the higher tides the preceding week. It may be worthwhile to establish a camp in order to trap during the nocturnal tides of this critical portion of the return window and to begin to work the trapped fish at first light. Some on-site or near-site security needs to be provided when the weir is in place in order to prevent illegal harvest.

There was at least one day where marking operations ceased before fish stopped coming through the fishway. Operations were discontinued to comply with FS water travel safety policy. Although it was not recorded in the field notes, this likely occurred on 8/21, the day of the second largest tide worked and the day of the most enhanced sockeye handled.

Some, if not many or all, returning 2-ocean enhanced sockeye were left out of the population estimate derived from mark-recapture results.

Freshwater Ripening

The technique of using sequentially numbered tags without weirs at the mouths of feeder streams was found to provide little information about ripening time and arrival on the spawning grounds relative to freshwater entrance. The fate of carcasses, and thus recovery of tags, involves many variables not related to freshwater ripening or entrance time.

These tags with numbers could be useful in future monitoring efforts if the same stock of tags is used. Tags found on the spawning gravels could be differentiated by number sequence used in previous years.

Estimate of Interception From CWT Recovery

Appendix VI, Comparative Summary of Sockeye Harvest Strata in Southeast Region, includes estimates of contribution by Virginia Lake based on tag ratios and expansion factors from CWT recoveries (ADFG, Tagotoweb). These

data are displayed for the purpose of comparing general trends. Trendlines for SE Enhanced and SE Common Property sockeye harvests appear comparable throughout the period displayed. Virginia Lake was likely still building in 1994, after which its trendline follows that of the other two levels of sockeye contribution. This provides a general picture of the trend in overall run strength. If the proportion of harvest remains nearly the same over time, escapement should follow a similar trend.

Escapement Surveys

It appears that surveys may well have missed peak spawning escapement this year. CWT recoveries indicate that harvest was reduced this year from last year (Appendix VI), perhaps reflecting reduced ocean survival which might or might not be a result of this year's ENSO (El Nino Southern Oscillation). It is not known if this anomaly might have had any effect on run timing. An unprecedented (for Virginia Lake) amount of lake ***beach spawning*** might have made a big difference in what was seen/not seen in the creeks. Greater effort needs to be put toward hitting and surrounding the anticipated week of peak escapement. This will require giving Virginia Lake escapement surveys a higher priority in the order of project task accomplishment.

Recommendations for Next Year's Adult Monitoring

1. Put more effort into obtaining weekly escapement surveys beginning the second week in September. This may require an adjustment in project priorities.
2. Install flashboard during late winter/early spring low-water period. Conduct tests during weir operation to determine usefulness.
3. Check published ADFG design of restraint cradle to see whether existing cradle can be improved.
4. Establish a field camp during the peak tides of the return window to determine nocturnal migration rate.
5. Develop a configuration for use of the restraint cradle away from the training wall during high-water periods.
6. Effort needs to be put toward determining an estimate of the 2-ocean component of the enhanced return. Scale sampling and analysis along with closer differentiation of data at the time of measurement and recording should help refine the characterization of the total return.

Appendix I. Mill Creek Fishway with intermittent weir installed.



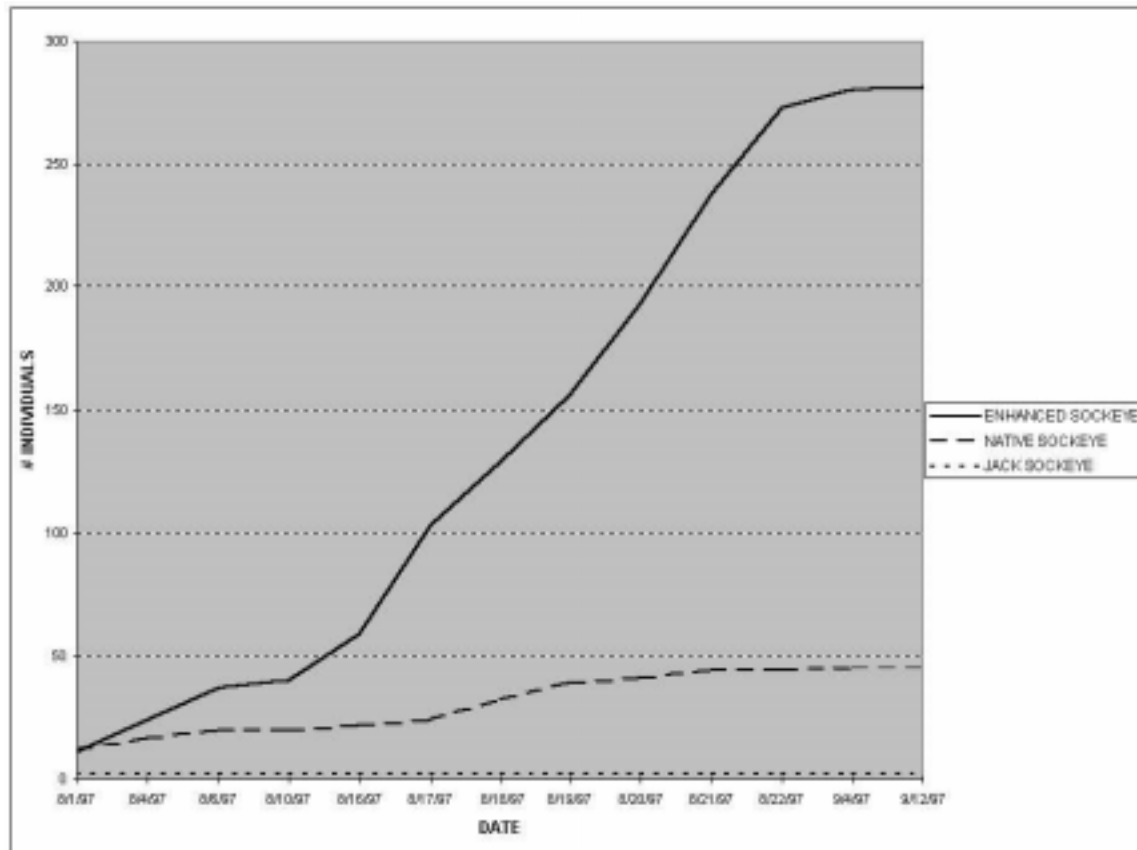
Appendix II. Restraint cradle for measuring and marking adult sockeye.



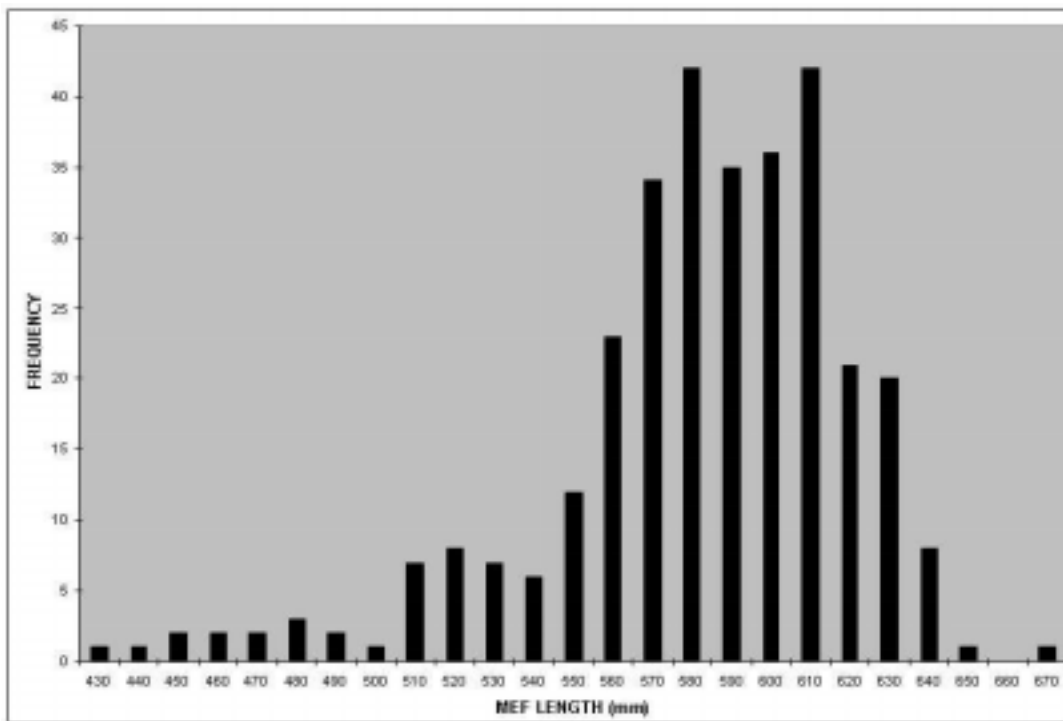
Appendix III. Virginia Lake enhanced sockeye at the Mill Creek intermittent weir.



Appendix IV. Cumulative Handling Summary of All Sockeye, Mill Creek Intermittent Weir, 1997



Appendix V. Length-Frequency Histogram for All Sockeye, Mill Creek Intermittent Weir, 1997



Appendix VI. Comparative Summary of Strata of Sockeye Harvest in Southeast Region

